Edited by

Sunit Ghosh | Florian Falter | David J. Cook

Cardiopulmonary Bypass

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Medicine

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Preface

This book has been written to provide an easily readable source of material for the everyday practice of clinical perfusion. For the past few years there has been a dearth of books, other than large reference tomes, relating to cardiopulmonary bypass. We hope that newcomers to the subject will find this book useful, both in the clinical setting and in preparation for examinations, and that more experienced perfusionists and medical staff will find it useful for preparing teaching material or for guidance.

We would like to thank everyone who helped in the preparation of the manuscript, particularly those who contributed their expertise by writing chapters for this book.

S. Ghosh, F. Falter and D. J. Cook

Chapter 1

Equipment and monitoring

Victoria Chilton and Andrew Klein

The optimum conditions for cardiothoracic surgery have traditionally been regarded as a "still and bloodless" surgical field. Cardiopulmonary bypass (CPB) provides this by incorporating a pump to substitute for the function of the heart and a gas exchange device, the "oxygenator," to act as an artificial lung. Cardiopulmonary bypass thus allows the patient's heart and lungs to be temporarily devoid of circulation, and respiratory and cardiac activity suspended, so that intricate cardiac, vascular or thoracic surgery can be performed in a safe and controlled environment.

History

In its most basic form, the CPB machine and circuit comprises of plastic tubing, a reservoir, an oxygenator and a pump. Venous blood is drained by gravity into the reservoir via a cannula placed in the right atrium or a large vein, pumped through the oxygenator and returned into the patient's arterial system via a cannula in the aorta or other large artery. Transit through the oxygenator reduces the partial pressure of carbon dioxide in the blood and raises oxygen content. A typical CPB circuit is shown in Figure 1.1.

Cardiac surgery has widely been regarded as one of the most important medical advances of the twentieth century. The concept of a CPB machine arose from the technique of "cross-circulation" in which the arterial and venous circulations of mother and child were connected by tubing in series. The mother's heart and lungs maintained the circulatory and respiratory functions of both, whilst surgeons operated on the child's heart (Dr Walton Lillehei, Minnesota, 1953, see Figure 1.2a). Modern CPB machines (see Figure 1.2b) have evolved to incorporate monitoring and safety features in their design.

John Gibbon (Philadelphia, 1953) is credited with developing the first mechanical CPB system, which he used when repairing an atrial secundum defect (ASD). Initially, the technology was complex and unreliable and was therefore slow to develop. The equipment used in a typical extracorporeal circuit has advanced rapidly since this time and although circuits vary considerably among surgeons and hospitals, the basic concepts are essentially common to all CPB circuits.

This chapter describes the standard equipment and monitoring components of the CPB machine and extracorporeal circuit as well as additional equipment such as the suckers used to scavenge blood from the operative field, cardioplegia delivery systems and hemofilters (see Tables 1.1 and 1.2).

Tubing

The tubing in the CPB circuit interconnects all of the main components of the circuit. A variety of materials may be used for the manufacture of the tubing; these include polyvinyl chloride

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